

## **Attachment 1**

### **Proposed Regulation Order (DRAFT) Verification Procedure for Diesel Retrofit Systems**

#### **§ 2700. Applicability.**

These procedures apply to retrofit emission control systems to be used on petroleum-fueled diesel engines.

(a) A diesel retrofit system intended to achieve particulate matter (PM) emission reductions will be categorized as follows:

- (1) Level one: the system has been shown under these procedures to reduce PM emissions by at least 30 percent and less than 60 percent.
- (2) Level two: the system has been shown under these procedures to reduce PM emissions by at least 60 percent and less than 85 percent.
- (3) Level three: the system has been shown under these procedures to reduce PM emissions by at least 85 percent, or to achieve PM levels of 0.01 grams per brake-horsepower-hour (g/bhp-hr) or less.

(b) A diesel retrofit system intended to achieve oxides of nitrogen (NOx) emission reductions will be categorized according to percentage reduction from baseline.

NOTE: Authority cited: Sections 39600, 39601, 43013, 43018 and 43105, Health and Safety Code. Reference: Sections 43000, 43009.5, 43013, 43018, 43101, 43104, 43105, 43106, 43107, and 43204-43205.5, Health and Safety Code.

#### **§ 2701. Definitions.**

(a) The definitions in Section 1900 (b), Chapter 1, Title 13 of the California Code of Regulations apply, with the following additions:

- (1) "ARB Enforcement Officer" means any officer or employee of the Air Resources Board so designated in writing by the Executive Officer or by the Executive Officer's designee.
- (2) "Average" means the arithmetic mean.
- (3) "Backpressure Monitor" means a control module that includes a sensor for measuring the engine backpressure and an indicator to notify the operator when the backpressure exceeds specified limits defined by the engine manufacturer.
- (4) "Diesel Engine" means a type of engine with operating characteristics significantly similar to the theoretical diesel combustion cycle. The primary means of controlling power output in a diesel cycle engine is by limiting the

amount of fuel that is injected into the combustion chambers of the engine. A diesel cycle engine may be petroleum-fueled (i.e., diesel-fueled) or alternate-fueled.

- (5) "Durability" means a vehicle's or engine's ability to maintain a given emissions level over its minimum durability period defined by ARB. The minimum durability testing periods are not meant to be representative of the useful life of the retrofit system in actual service.
- (6) "Diesel Retrofit System" means any device added to the engine or equipment after manufacture that is intended to reduce emissions. Examples of Diesel Retrofit Systems include, but not limited to a particulate filter, diesel oxidation catalyst, selective catalytic reduction system, or a combination of the above.
- (7) "Low Sulfur Diesel Fuel" means diesel fuel with a sulfur content less than 15 parts per million by weight (ppmw).
- (8) "Regeneration" means the periodic or continuous combustion of collected particulate matter trapped in a filter, during regular engine operation, through active or passive mechanism. Active regeneration requires an external source outside normal operation to regenerate the emission control system. Examples of active regeneration are the use of exhaust fuel injection or the use of heating mechanisms on particulate filters to initiate combustion of collected particulate matter. Passive regeneration does not require another source other than normal operation to regenerate the emission control system. Examples of passive regeneration are the fuel-borne catalyst or a catalyst-coated particulate filter in which the initiation of regeneration cycle depends on the exhaust temperature.

NOTE: Authority cited: Sections 39600, 39601, 43013, 43018, 43101, 43104, and 43105, Health and Safety Code. Reference: Sections 39002, 39003, 43000, 43009.5, 43013, 43018, 43100, 43101, 43101.5, 43102, 43104, 43105, 43106, 43107, and 43204-43205.5, Health and Safety Code.

## **§ 2702. Testing Requirements.**

(a) (1) Certified Engines. For engines that have been certified, the retrofit system must be tested on an engine family basis (as described in the Code of Federal Regulations 40 Part 86, 89 and Title 13 of the California Code of Regulations). The manufacturer must identify the specific engine family and applications (e.g., engine make, model, model year and vehicle application) for which the emission reduction claims hold.

(2) Uncertified Engines. For engines that have not been certified, the manufacturer must identify the engine manufacturer, make, model, model year, PM emission rate, exhaust temperature, and application for which the retrofit system is applicable.

(b) Engine Pre-conditioning. The manufacturer may tune-up or rebuild the engine only prior to baseline testing. Any tests conducted subsequent to a tune-up or rebuild will be considered a baseline test.

(c) Retrofit System Pre-conditioning. The engine with retrofit system must be operated for a break-in period of at least 25 hours.

(d) Test Fuel. The test fuel must meet the specifications in the California Code of Regulations (Subsections 2280 through 2283 of Title 13), with the exception of the sulfur content or other properties previously identified by the manufacturer and approved by the Executive Officer. The sulfur content of the test fuel must be no less than 66 percent of the stated maximum sulfur content for the retrofit system, unless the testing was performed with fuel containing less than 15 ppmw sulfur. Testing of transit buses must use low-sulfur diesel fuel.

(e) Test Cycle. The test engine or vehicle must be tested on a series of operating test cycles as indicated in Table 1. Baseline tests (without the retrofit system) must be performed for each cycle at least as many times as shown in Table 1.

- (1) On-road Engines and Vehicles. For on-road diesel-fueled vehicles, the manufacturer must choose between engine testing and chassis testing. Engine testing may be used for verification of an absolute engine emissions level or a percent emission reduction. Chassis testing may be used only to verify a percent emission reduction. If the manufacturer intends to use the initial data as durability data, the manufacturer must follow the same testing option throughout. Engine testing must consist of one cold-start and at least three hot-start of the Federal Test Procedure (FTP) Heavy-duty Transient Cycle for engines used in on-road applications (see Code of Federal Regulations, Title 40, Part 86, appendix I (f)(2)). Chassis testing must consist of one cold-start and at least three hot-start tests using the Urban Dynamometer Driving Schedule (UDDS) (see Code of Federal Regulations, Title 40, Part 86, appendix I (d)) or another representative chassis test cycle with ARB approval, and three hot-start New York Bus Cycle (NYBC) test. The manufacturer must conduct all tests in accordance with the provisions of Code of Federal Regulations, Title 40, Part 86, Subpart N.
- (2) Off-road Engines and Equipment (including portable engines). For off-road diesel-fueled vehicles and equipment, the manufacturer must follow the steady-state test cycle outlined in the ARB off-road regulations (California Code of Regulations, Title 13, Section 2423 and the incorporated California Exhaust Emission Standards and Test Procedures for New 2000 and Later Off-Road Compression-Ignition Engines, Part I-B). A minimum of three tests must be conducted for each appropriate test cycle.

- (3) Stationary Engines. For stationary engines, the manufacturer must use the most appropriate off-road test cycle representing the operating condition of the application, with approval from the ARB Enforcement officer. A minimum of three tests must be conducted for each appropriate test cycle.

Table 1. Test Cycles for Emission Reduction Testing

Test Type	On-Road	Off-Road (including portable engines)	Stationary
Engine	FTP Heavy-duty Transient Cycle (1 cold-start and 3 hot-starts)	Steady-state test cycle from ARB off-road regulations	Steady-state test cycle from ARB stationary regulations
Chassis	UDDS* (1 cold-start and 3 hot-starts) and NYBC (3 hot-starts)	N/A.	N/A.

\* UDDS can be substituted with another ARB approved cycle.

FTP = Federal Test Procedure

UDDS = Urban Dynamometer Driving Schedule

NYBC = New York Bus Cycle

(f) Emissions Testing. For any retrofit system with a distinct regeneration event, the hot-start portion of the test cycle must be repeated until at least one regeneration event occurs. The average of all valid test cycle repetitions between regeneration events will be used for retrofit system verification, including a minimum of one regeneration event.

(g) Results. For all emission tests, the manufacturer must report emissions of total PM, non-methane hydrocarbons or total hydrocarbons (whichever is used for the relevant engine or vehicle certification), oxides of nitrogen, and carbon monoxide. Any brake specific emissions must not exceed applicable emission standards authorized by the California Code of Regulation, Title 13.

(h) Additional Exhaust Analysis. Should the Executive Officer have reason to believe that there may be an increase of toxic air contaminants as a result of the installation of a diesel retrofit system, the Executive Officer may require the manufacturer to perform additional exhaust analyses. Criteria to be considered by the Executive Officer include, but are not limited to: the addition of any substance to the fuel, intake air, or exhaust stream; whether a catalytic reaction is known or reasonably suspected to increase toxic air contaminants or other undesirable species, including ozone precursors; and field experience. This may include analyses of PM, benzene, 1,3-butadiene, formaldehyde, acetaldehyde, nitro-polyaromatic hydrocarbons, ammonia, and nitrogen dioxide.

NOTE: Authority cited: Sections 39600, 39601, 43013, 43018 and 43105, Health and Safety Code. Reference: Sections 43000, 43009.5, 43013, 43018, 43101, 43104, 43105, 43106, 43107, and 43204-43205.5, Health and Safety Code.

### **§ 2703. Durability Testing Requirements**

(a) The manufacturer must demonstrate the retrofit system's emission durability through actual field or bench testing, subject to the approval of an ARB enforcement officer. If the manufacturer has previously demonstrated durability for the identical system in a prior verification, the manufacturer may request the Executive Officer to accept the previous demonstration. In evaluating the request, the Executive Officer will consider similarity of baseline emissions and application duty cycles, in addition to any other relevant factors.

(b) Engine Selection. The manufacturer may choose the engine and application in the durability demonstration. The engine and application should be representative of the engines and applications for which verification is sought. The selected engine does not need to be the same as the engine used for emissions reduction.

(c) Durability Test Period. The minimum durability testing periods are shown in Table 2. For each engine type and size, the durability test period is that which occurs first. A manufacturer may request the Executive Officer approval to use an accelerated durability test plan which will demonstrate that the system's emission durability is at least as great as that identified in Table 2.

(d) Durability Test. The durability test consists of extended periods of time in which the retrofit system operates in the field or bench aging on a cycle proposed by the manufacturer and approved by the Executive Officer, and undergoes emission reduction testing as described in Table 3. Emission tests of the retrofit system are required at the three points: initial (nominal zero hours), intermediate (between 33 and 67 percent of the full durability period), and final (100 percent or greater than full durability period). Baseline testing (without the retrofit system) is required only at the initial point.

(e) Test Cycle. Only one test cycle is required at the initial, intermediate, and final point of the minimum durability period. For on-road application, the manufacturer may choose the NYBC or UDDS or ask the Executive Officer to approve the use of an alternative cycle. For off-road and stationary application, the manufacturer may choose an appropriate cycle as defined in § 2702 or ask the Executive Officer to approve the use of an alternative test cycle. A minimum of three hot-start tests is required. All testing must follow the fuel and results requirements described in § 2702 (d) and (g), respectively.

Table 2. Minimum Durability Testing Periods

Engine Type	Engine Size	Minimum Durability Testing Period	
On-Road	Light heavy-duty, generally 70 to 170 hp, Gross Vehicle Weight Rating (GVWR) normally less than 19,500 lbs.	5 years or 60,000 miles (or equivalent time in hours)	
	Medium heavy-duty, generally 170 to 250 hp, GVWR normally from 19,500 lbs. to 33,000 lbs.	5 years or 100,000 miles (or equivalent time in hours)	
	Heavy heavy-duty, generally exceeds 250 hp, GVWR normally exceeds 33,000 lbs.	5 years or 150,000 miles (or equivalent time in hours)	
Off-Road (including portable engines) and Stationary	Under 25 hp, and for constant speed engines rated under 50 hp with rated speeds greater than or equal to 3,000 rpm	3 years	1,600 hours
	At or above 25 hp and under 50 hp	4 years	2,600 hours
	At or above 50 hp	5 years	4,200 hours

Table 3. Emission Tests Required for Durability Demonstrations

Application	Test Type	Test 1 (0% of durability period)	Test 2 (between 33 to 67% of durability period)	Test 3 (100% of durability period)
On-Road	Engine	FTP Heavy-duty Transient Cycle (1 cold and 3 hot-starts)		
	Chassis	UDDS (1 cold and 3 hot-starts), NYBC (1 cold and 3 hot-starts), or ARB approved test cycle		
Off-Road and portable engines	Engine	Appropriate steady-state test cycle		
Stationary	Engine	Appropriate steady-state test cycle		

\* Baseline testing (without the retrofit system) is required only in Test 1.

(f) Maintenance During Durability Testing. Except for emergency engine repair, only scheduled maintenance may be conducted on the engine and retrofit system during the durability demonstration. If normal maintenance includes a change of any component of the retrofit system, the time (miles, years, or hours) between component change must be included with the results of the demonstration.

(g) Performance Requirements. Throughout the durability demonstration period, the retrofit system must meet the following requirements:

- (1) If the manufacturer claims a percent emission reduction, the percent emission reduction must not be less than the initial verified percent emission reduction.
- (2) If the manufacturer claims a reduction in emission level, the emission level must not exceed the initial verified emission level.
- (3) The retrofit system must maintain its physical integrity. That is, its physical structure and all components not specified for regular replacement must remain intact and fully functional.
- (4) The retrofit system must not cause any damage to the engine.
- (5) Maintenance of the retrofit system beyond that specified in the retrofit system's manual will only be allowed with prior ARB approval.

(h) Failure During Durability Demonstration Period. If, for any reason other than engine failure, the retrofit system does not maintain its initial verified percent emission reduction or emission level, the verification level of the retrofit system will be downgraded to the relevant emission reduction level. If the retrofit system fails to maintain at least 30 percent PM reduction during the durability period, no PM emission credit will be granted to the end-users. In the event that the retrofit system experiences a catastrophic failure that prevents the retrofit system from functioning during the remainder of the durability demonstration period, the manufacturer must cease selling the retrofit system and provide a full refund to the purchaser. In addition, the manufacturer must provide a full investigative report detailing the causes of the catastrophic failure to ARB within 90 days of the failure.

#### **§ 2704. Certification Documentation.**

(a) General Description. The manufacturer must submit a general description of the retrofit system, including discussion on the principles of operation and a schematic depicting operation. Note that a retrofit system dependent on two or more individual systems must be evaluated as one system. The manufacturer must also report the emission reduction claim, and identify the specific engine family and application for which it seeks verification.

(b) Retrofit System Compatibility. In order to establish that the retrofit system is compatible with the selected applications, the manufacturer must indicate the ranges of physical conditions under which the retrofit system operates and the conditions that

could cause a reduction in performance. The manufacturer must identify favorable and unfavorable conditions for the retrofit systems (e.g., extended periods of idling). In addition, the manufacturer must identify the effects of the retrofit system on overall engine performance and oil consumption. The manufacturer must provide temperature profiles, average duty cycles, and other relevant parameters from field-collected data of the intended applications. These data must be compared with the operational requirements of the retrofit system to ensure proper design.

(c) Quality Control of Test Data. The manufacturer must provide information on the test facility, test procedure, and equipment used in the emission and durability testing. The manufacturer must provide quality control data establishing that the test equipment used meets specifications and calibrations given in Code of Federal Regulation, Title 40, Part 85, subpart N.

(d) Additional Information. The manufacturer must provide additional environmental safeguard information as deemed necessary by ARB. For example, the manufacturer may be required to submit data on engine oil consumption and ash content, subject to ARB's discretion.

(e) Engine Backpressure. The manufacturer must demonstrate that the backpressure caused by its retrofit system is within the engine manufacturer's specified limits, or will not result in any damage to the engine. If operation of the engine with the retrofit system installed will result in a gradual build up of backpressure that will eventually exceed the engine's specified limits, information describing the reduction of backpressure must be included.

(f) Backpressure Monitoring. All filter-based retrofit systems must be installed with a backpressure monitor to ensure the operator is notified when the backpressure limits, as specified by the engine manufacturers, are approached. The manufacturer must also provide information on the thresholds and control logic that are integrated into the retrofit system and whether the control logic requires any changes from engine to engine and/or application to application.

(g) Fuel Requirements. The manufacturer must identify any fuel requirements for proper functioning of the retrofit system. The manufacturer must also identify any expected consequences due to misfueling, as well as methods for reversing any negative effects.

(h) Defects Warranty. The manufacturer must provide a defects warranty with minimum coverage as shown in Table 4. For each engine type and size, the defects warranty period must be that which occurs first. During the defects warranty period, the manufacturer will be liable for any defects in the retrofit system that present themselves in the course of normal operation. A defect may be structural, mechanical, or chemical in nature. If a retrofit system's emission reduction performance decreases below the level it was certified to within the warranty period, the system will be considered defective.



Table 4. Minimum Defects Warranty Periods

Engine Type	Engine Size	Minimum Durability Testing Period
On-Road	Light heavy-duty, generally 70 to 170 hp, GVWR normally less than 19,500 lbs.	4 years or 40,000 miles
	Medium heavy-duty, generally 170 to 250 hp, GVWR normally from 19,500 lbs. to 33,000 lbs.	4 years or 65,000 miles
	Heavy heavy-duty, generally exceeds 250 hp, GVWR normally exceeds 33,000 lbs.	4 years or 100,000 miles
Off-Road (includes portable engines) and Stationary	Under 25 hp, and for constant speed engines rated under 50 hp with rated speeds greater than or equal to 3,000 rpm	2 years or 1,100 hours
	At or above 25 hp and under 50 hp	3 years or 1,800 hours
	At or above 50 hp	4 years or 2,800 hours

(i) Maintenance Requirements. The manufacturer must identify all normal maintenance requirements for the retrofit system. The manufacturer must specify the recommended intervals for cleaning and/or replacing components of the retrofit system. Any components to be replaced within the defects warranty period must be included in the original retrofit system or included free of charge to the customer at the maintenance intervals. In addition, the manufacturer must specify procedures for proper handling and disposal of spent components and/or materials cleaned from the filter medium. For filter-based retrofit system, the manufacturer must include procedures for resetting any backpressure monitors after maintenance procedures are completed.

(j) System Labeling. The manufacturer must provide a label on the retrofit system, which identifies the manufacturer, model, and the month and year of manufacture. A scale drawing of a sample label must be submitted.

(k) Owner's Manual. The manufacturer must provide a copy of the retrofit system's manual, which must clearly specify the following information:

- (1) Warranty statement including the warranty period over which the manufacturer is liable for any defects.
- (2) Installation and maintenance requirements for the retrofit system.
- (3) Fuel consumption penalty, if any.
- (4) Fuel sulfur limitation.

- (5) Instructions for reading and resetting the backpressure monitor.
- (6) The manufacturer's contact information for replacement components and cleaning agents.
- (7) Contact information for an end-user to determine proper ways to dispose of waste generated by the retrofit system (e.g., ash accumulated in filter-based systems). At a minimum, the owner's manual should indicate that disposal must be in accordance with all applicable Federal, State and local laws governing waste disposal.

NOTE: Authority cited: Sections 39600, 39601 and 43105, Health and Safety Code.  
Reference: Sections 43000, 43009.5, 43018, 43101, 43104, 43105, 43106, 43107, and 43204-43205.5, Health and Safety Code.

#### **§ 2705. Verification Determination.**

(a) Determination of Emission Reduction for Emission and Durability Testing. The verification of diesel retrofit system's emission reduction from the ARB will be based on the average of valid test results before and after the installation of the retrofit system. For percent reduction, it is the difference of the average emissions without and with the retrofit system divided by the average emissions without the retrofit system. For absolute emission reduction, it is the average emission level with the retrofit system.

(b) Determination of Emission Reduction Credit. Based on the verified emission reduction from both emission and durability testing, ARB will determine and categorize the retrofit system for PM as level one, level two, or level three system. Similarly, based on the verified emission reduction from both emission and durability testing, ARB will determine the emission reduction credit for NOx.

(c) Conditional Verification. If ARB is convinced that the engine and application characteristics for a retrofit system are technically feasible, a conditional verification may be granted upon completion of 33 percent of the minimum durability period. Criteria considered by the ARB include but are not limited to the design of the retrofit system, filter substrate, catalyst substrate used, similarity to already verified systems, application of the retrofit system, other relevant testing data, and field experience. Full verification would be contingent on completion of the durability testing and submission of test results. These results must be submitted within a year after receiving conditional verification if bench aging is used and within three years if field testing is used.

NOTE: Authority cited: Sections 39600, 39601 and 43105, Health and Safety Code.  
Reference: Sections 43000, 43009.5, 43018, 43101, 43104, 43105, 43106, 43107, and 43204-43205.5, Health and Safety Code.